

Valve

The invention which is the subject of this application relates to a valve and improvements which allow the same to operate in an improved manner.

There are many different forms of valve which are provided for use in specific operating environments and to provide particular operational requirements.

One known type of valve is the double block & bleed (DBB) valve which are now commonly used in the processing industries.

There are several versions of DBB valves currently available, with each version typically having features that enhance use, performance or safety.

One form of DBB valve is the ball valve version. In this version there are provided first and second common ball valves which are assembled side by side and inline. An intervening bleed valve is provided between the two ball valves which results in the term double block (two ball valves) and Bleed, DBB.

The common ball valves which are used typically are generally available in two design types, the floating ball or trunnion mounted type. These two types of ball valve work in quite different ways to produce an effective seal against a pressurised process medium such as a fluid passing along a pipeline in which the valve is positioned and which, when the valve is closed, is prevented from flowing along the pipeline past the valve.

The floating ball type has static seats or seals and a ball which is movable under the influence of pressure being applied to one side of the floating ball such that the ball contained within the

valve is pushed toward a static seat downstream of the ball to make a pressure tight seal. The disadvantage with this design is that as the pressure is applied, the ball moves towards the downstream seat and as it moves it releases the compression on the static upstream seat. This therefore means that the pressurised medium can then pass through the upstream seat due to lack of compression and fills the ball cavity. This therefore means that at any given time in practical operation only one seat is performing the sealing operation and this is the static seat downstream of the fluid which is applying the pressure on the ball. Thus, should the downstream seat fail there is no further seat to prevent leakage/failure.

The trunnion mounted ball design has a static ball and dynamically movable seats. In this case if pressure is applied to one side of the trunnion mounted ball valve, the ball remains static and the upstream seat is pushed toward the static ball to make a pressure tight seal. The disadvantage with this design is that if the upstream seat fails the downstream seat would be pressurised by the fluid and be pushed in the wrong direction away from the ball and leakage/failure occurs.

Due to the inherent single barrier offered by these common single ball valve designs the use of DBB valves has become popular as they offer two barriers in one common valve assembly.

The aim of the present invention is to provide further improvements to the operation of valves, including the single ball variety, and to provide a double sealing action within the valve.

In a first aspect of the invention there is provided a valve, said valve having a ball and first and second sealing means against

which the ball is selectively positioned to provide a sealing effect when the valve is in a closed position and wherein the first and second sealing means both provide a sealing effect with respect to said ball when under the influence of a pressurised fluid within a pipeline to which the valve is fitted.

In one embodiment the sealing means or seats provide a seal against opposing sides of the ball, typically the first sealing means being positioned upstream and the second sealing means positioned downstream of the ball with respect to the flow of fluid along the pipeline. Typically the fluid is the normal fluid which flows along the pipeline such as gas, oil, water or the like.

Typically the ball has a port passing therethrough, said ball rotatable with respect to the valve body to be movable between an open position in which the port is in line with the pipeline to which the valve is connected and a closed condition in which the openings into the port are sealed off from the pipeline by the sealing means.

In one embodiment the common pressure source is the fluid passing along a pipeline on which the valve is fitted.

In one embodiment the ball which is used is a modification of the ball of the type used in a floating ball valve design and the first and second sealing means which are used are modified pressure dynamic seats of the type used in a trunnion mounted ball valve design such that, in a previously unknown manner, the sealing means and the ball are all movable with respect to the valve body to create the sealing effect.

In one embodiment both upstream and downstream sealing means or seats work simultaneously under one pressure source from one direction.

In accordance with the invention there is provided a valve with one ball and two sealing means acting as pressure barriers thus allowing a compact valve to be provided with a single ball element that offers double block/pressure barrier isolation capability. This in turn provides advantages in terms of reduction of size and cost.

In one embodiment two of the valves in accordance with the invention, or a valve in accordance with the invention and another valve, are mounted in line to provide a two ball element valve that has quadruple block/pressure barrier isolation capability for extra safety and reliability.

In one embodiment the valve can include an intervening bleed valve and/or intervening port/s for the reception of sensing instruments, probes, sampling/process removal or injection/introduction equipment or any combination thereof.

All embodiments can be fitted with other intervening devices between the seats or valves.

In one embodiment, the valve in accordance with the invention can be fitted in conjunction with a check or non-return valve at either end of the same to allow the subsequently formed valve assembly to function uni-directionally. In one embodiment the valve assembly in this form is used to allow services such as the injection of materials into the pipeline and/or removal of samples from the pipeline to be performed.

In a further aspect of the invention the ball of the valve as herein described is provided with a valve which allows the downstream side of the valve to be vented.

In operation, once the cavity in which the ball is mounted has a fluid pressure drop due to the occurrence of venting of the valve upstream, the downstream pressure is greater than that in the cavity and pushes the valve open which allows communication with the downstream side of the valve and allows the venting of the downstream side of the valve.

In one embodiment, at least one pressure sensor is provided in the valve in the cavity in which the ball sits. The pressure sensor can be provided to detect change in pressure of the fluid in the cavity and an increase in pressure of the fluid in the cavity indicating failure of the seal upstream of the ball. However, as, in accordance with the invention, there is provided a seal downstream of the ball in addition to that upstream of the ball, so the valve will still operate but the change in pressure can be used as an indicator that the upstream valve seal is required to be replaced and can be done prior to the valve itself failing.

In a further embodiment, the ball is capable of movement within the cavity of the valve and the sealing means upstream of the ball is capable of limited movement to and from said ball. In turn, the ball, with the upstream sealing means in engagement therewith, is movable under the influence of the pressurised fluid onto the sealing means downstream of the ball which in turn is moveable to a limited extent in the valve. Thus, the sealing relationship within the valve is formed between the seal upstream which is movable, the ball which is movable and the seal downstream which is movable such that the sealing effect can be created between the ball and the upstream and downstream seals.

In one embodiment, the sealing means upstream of the ball is provided with mechanical advantage such that the effect of the pressurised fluid on the first face of the seal generates an

increased pressure at the opposing sealing face between the sealing means and the ball.

Typically, the limited movement of the first and second seals in the valve is less than that for the sealing means in the conventional ball valve arrangements.

In one embodiment the movement of the ball and sealing means is limited in terms of length of movement such that when in a closed position pressurised seals are created between the upstream sealing means and a first side of the ball and the downstream sealing means and an opposing side of the ball.

Typically the sealing means positioned upstream of the ball is provided to be movable towards the ball under the influence of pressure at a first level applied by fluid in the pipeline flowing towards the valve, to form a first seal on the ball and the ball and said sealing means, with the first seal maintained, are provided to be movable towards the sealing means positioned downstream of the ball under the influence of said fluid at the same or greater pressure level to form the second seal.

Preferably the ball and said sealing means are provided to move towards the sealing means downstream of the ball, when a pressure at a level greater than the first pressure level is reached. Typically wherein the sealing means positioned downstream of the ball is provided to move within a limited extent when the pressure level which moves the ball is reached.

In one embodiment of the invention, as the ball is capable of movement within the cavity of the valve, the stem which is provided to allow rotation of the ball between open and closed positions, is provided with engagement means on said ball to allow movement of the ball to be achieved but still allow

operation of the ball between open and closed positions by movement of the stem.

In a further embodiment, there are provided double sealing arrangements within the stem, ends and seats of the valve so as to provide improved safety.

In a further aspect of the invention there is provided a valve having at least one ball and first and second sealing means to provide seals on opposing upstream and downstream sides of the ball wherein the sealing means positioned upstream of the ball is provided to be movable towards the ball under the influence of pressure at a first level applied by fluid in the pipeline flowing towards the valve, and the ball and said sealing means are provided to be movable towards the sealing means positioned downstream of the ball under the influence of said fluid at the same or greater pressure level.

Typically the ball and said sealing means are provided to move towards the sealing means downstream of the ball, when a pressure at a level greater than the first pressure level is reached.

Specific embodiments of the invention are now described as reference to the accompanying drawings wherein:-

Figure 1 illustrates prior art ball valve systems,

Figures 2a and b illustrate a first embodiment of the invention in section,

Figures 3a and b illustrate a second embodiment of the invention in section,

Figures 4a-c illustrate a further embodiment of the invention,

Figures 5a-c illustrate a yet further embodiment of the invention,

Figures 6a-c illustrate a yet further embodiment of the invention.

Figures 7a-c illustrate a further embodiment of the invention,

Figure 8a-c illustrate a further embodiment of the invention,

Figure 9a-c illustrate a further embodiment of the invention, and

Figure 10 illustrates a further embodiment of the invention.

Referring firstly to figure 1 there is illustrated two prior art ball valve sealing systems. In the first system, referred to as a floating ball sealing system, there is provided a ball (a) mounted in the valve cavity, not shown, and in the figure 1a there is shown the ball (a) with an upstream seal (b) and downstream seal (c) in the normal conditions in ambient pressure. However, when a liquid flows along the pipeline to which the valve is connected, as indicated by arrows (d) so pressure is applied to the ball (a) as indicated by the arrows (d). As the ball effectively floats within the cavity of the valve, the ball is moved as indicated by arrows (e) towards the downstream seal (c) so that an effective seal at portion (f) is achieved. However, if this seal (f) fails then there is no longer any other seal in the valve such that the fluid can then flow through the seal and the valve is ineffective.

Referring to figures 1c and d there is illustrated an alternative ball valve arrangement wherein the ball (a) is again provided with downstream seal (b) and upstream seal (c). However, in this arrangement, the ball is fixed in position and when fluid pressure is applied to the upstream seal (b) as indicated by

arrows (d) then the upstream seal (b) moves as indicated by arrows (e) against the ball to form the effective seal at portion (f).

In this case, if the seal at (f) is broken then the fluid can enter the cavity in which the ball is mounted and then force the downstream seal c away from the ball as indicated by arrows (g) so that the valve leaks.

Turning now to figures 2a and b there is illustrated a first embodiment of the invention which is shown in section along the longitudinal centre line of the valve body and shows the valve in a closed position in figure 2a and an open position is shown in Figure 2b with the fluid flowing through the valve as indicated by arrow 2. The valve includes a valve body 4, and a valve stem 6 and handle arrangement 8 which is connected to operate a ball 10 and allow the same to be rotated in a cavity 12 between the closed position, in which the fluid is prevented from passing through the cavity in the valve, and an open position in which the fluid can pass through the port in the ball, through the cavity in the valve and hence downstream along the pipeline as shown in figure 2b.

Provided in location in the valve are an upstream sealing means or seat 14 and a downstream sealing means or seat 16. The valve includes a number of other components provided to locate the various components in position but these components are largely conventional and therefore will not be described.

In the open position, the upstream and downstream sealing means 14, and 16 are not providing a closing seal on the ball. When the valve is in the closed position shown in figure 2a, the pressure of the fluid entering the valve in the direction indicated by arrow 2, causes the upstream sealing means 14 to move

towards the ball as indicated by arrow 16. This movement creates a seal between the sealing means and the ball at the portion 18. In accordance with the invention, the movement of the sealing means 14 against the ball is provided to have a mechanical advantage in that the seal created with the ball is at a greater pressure than the pressure of fluid acting on the sealing means 14. Furthermore, the sealing means 14 is capable of moving to a limited degree along the portion 20 of the valve body and is provided with piston seals 22 around the same. In accordance with the invention, the ball 10 is moveable within the cavity and therefore once the force of the sealing means on the ball has reached a certain pressure the sealing means 14 acts to move the ball 10 in the direction of arrow 24 within the cavity whilst maintaining the seal between the upstream sealing means 14 and the ball at portion 18.

The movement of the ball 10 in the direction of arrows 24 causes the same to contact with the downstream sealing means 16 and provide a seal at portion 26. The downstream sealing means 16 is also moveable to a limited extent within the portion 28 as indicated by arrow 30. Thus, in accordance with the invention, there is provided a first sealing arrangement upstream of the ball and a second sealing arrangement downstream of the ball with both first and second seals being effective such that should a first seal fail then the other seal can still be maintained. The provision of the movement of the upstream sealing means 14 onto the ball and the movement of the ball 10 onto the downstream sealing mean 16 with the upstream sealing means following the ball provides distinctive advantages. Firstly, there is provided a double seal arrangement in a valve body which only requires one valve ball arrangement. This reduces the cost of the manufacture of the valve and significantly reduces the length of the valve body in comparison to DBB valves whilst ensuring that a double block or seal is achievable.

Further advantages can be obtained as will now be described with reference to the further drawings which show further embodiments of the invention and uses similar components to those shown in figures 2a and b. For this reason, only new features will be provided with reference means in these drawings.

Figures 3a and b, show the provision of the valve with a port 32 leading into the cavity which allows access to be gained to the cavity through the port as required.

Figures 4a – c illustrate a valve arrangement in which there is provided a port 34 which allows the cavity 12 in which the ball is mounted to be accessed and purged of liquid. Furthermore, this valve is bidirectional in that it can be fitted either way round into the pipeline.

Figures 5a-c illustrate a further arrangement wherein the valve is again provided with a cavity port 34 to allow purging of the cavity and a downstream port 36 which allows the downstream part of the valve 38 to be purged or bled when the valve is in a closed position. In this arrangement the cavity and the downstream part of the valve to be purged are such that the position of the valve with respect to the pipeline can be reversed so that the cavity 12 and the upstream part of the valve can be purged.

Figures 6a-c illustrate a feature of the current invention wherein there is provided the port 34 for access to the cavity to allow the cavity to be purged and also, in accordance with this embodiment, the port 34 can be used to purge the downstream portion 38 of the valve. This is achievable via the port 34 as there is provided a check or non return valve 40 in the wall of the ball. Thus, when the ball is in the closed position, as shown

in figure 6a, the valve can be operated to purge the cavity 12 of liquid. Once this is achieved, the pressure differential between the cavity 12 and downstream portion 38 are such that the pressure in the downstream portion 38 causes the valve 40 to open thereby connecting the downstream portion 38 to the cavity 12 and causing the flow of liquid from the downstream portion 38 into the cavity 12 and through the port 34 and allows the same to be purged via port 34.

Figures 7a-c illustrate yet a further embodiment wherein there is provided a bleed port 44.

Figures 8a-c illustrate a yet further embodiment of the valve wherein is provided a pressure sensor 50 which is provided to detect the pressure of fluid within the cavity 12 and, as previously indicated, if the pressure of fluid within cavity 12 is found to increase significantly, then this is indicative of failure of the seal 18 between the upstream sealing means 14 and the ball as fluid is able to enter the cavity 12 past the seal 18 when in the closed position shown in figure 8a. In accordance with the invention this failure is not complete as the seal between the downstream sealing means 16 and the ball 10 is maintained so that fluid can still not enter the downstream portion 38 of the pipeline. However, the increase in pressure can be indicated to an operator of the valve system who would then repair the upstream sealing means 14 to ensure that the repair is made before the valve fails completely.

Figure 9a-c illustrate a further embodiment wherein there is provided a purge valve 60 both upstream and downstream of the ball 10 to allow the upstream portion 62 and downstream portion 38 to be purged separately as required.

Figure 10 indicates a further embodiment of the invention wherein there is provided an in line ball valve arrangement in accordance with the invention which, in this embodiment, shows two in line ball valve arrangements. The ball valve 10' is shown in a closed configuration and the upstream ball valve configuration 10 is shown in an open position thereby allowing the flow of liquid to the bleed port 34 to allow purging of the portion of the valve upstream from the ball valve 10'.

As a variation to the arrangement shown in Figure 10, two valves can again be provided, but in this case, one of the valves is in accordance with the invention and the other can be a conventional check or non-return valve. The provision of the check or non-return valve allows the assembly to be unidirectional in a direction dependent upon which end of the pipeline, i.e. towards the upstream or downstream of the flow, the non-return valve is positioned and fitted and the orientation used. This allows the provision of injection and sampling services to be performed into the pipeline.

There is therefore provided a valve assembly which allows, with a single ball, an effective double seal to be achieved both on the upstream and downstream sides of the ball. This is achieved by allowing limited and controlled movement of both the sealing means and the ball within the valve body such that when in a closed position the upstream sealing means is moved onto the ball to seal with the same under the influence of the fluid in the pipeline, and the ball and first sealing means can then move under increased pressure from the fluid to seal with the sealing means downstream of the ball.